Effects of dispersion on the evaluation of critical pumping rates in coastal aquifers.

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ABSTRACT

Management of coastal aquifers is a critical issue that remains a challenge. A number of methodologies have been developed to address optimal management of saltwater intrusion in coastal aquifers. Sharp interface models, wherein freshwater and seawater are assumed to be immiscible, has become quite widely used for the evaluation of maximum pumping rates because, together with the Dupuit assumption, facilitates linearization and provides a useful tool for developing analytical solutions. However, this approach is not accurate because seawater flow and the dispersive mixing zone are neglected. The mixing zone developed at the freshwater-seawater interface is one of the most important features in coastal hydrogeologic systems. Seawater flow and the width of the mixing zone are mainly controlled by three-dimensional pressures. Certainly, the rate of freshwater flow, the amplitude of the periodic stimulation, and the heterogeneity of the geological formations may influence the growth and decay of the mixing zone. In short, sharp interface models may provide a useful physical insight into the dynamics of seawater intrusion but not into realistic flow scenarios. Herein we propose to include the effects of dispersion on the single–potential formulation of Strack (1976) to estimate the error introduced by adopting the sharp interface approach. To this end, three-dimensional variable density flow simulations were carried out to evaluate the critical pumping rates. Different sets of simulations were performed by varying independently the distance of the well from the sea, the aquifer thickness and the longitudinal and transverse dispersivities. We seek a simple correction for the formulation of the critical pumping rate including mixing mechanisms and propose a more realistic optimization approach to control seawater intrusion. We study the effect of heterogeneity in the hydraulic conductivity field on the three-dimensional dynamics of seawater intrusion in a coastal aquifer with a pumping well.

Keywords: *Coastal aquifer, seawater intrusion, variable-density flow, dispersion, critical pumping rate.*

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